SECTOR COMPETITIVENESS FRAMEWORKS

CONSULTING ENGINEERING

PART 1 – OVERVIEW AND PROSPECTS

Industry Sector
Service Industries and Capital Projects

Secteur de l'industrie
Secteur des services et des grands projets

Canada

CONSULTING ENGINEERING

PART 1 – OVERVIEW AND PROSPECTS

PREPARED BY:
SERVICE INDUSTRIES AND CAPITAL PROJECTS BRANCH

This *Overview and Prospects* is the first of two companion documents on Consulting Engineering in the **Sector Competitiveness Frameworks** series, which is being produced by Industry Canada in partnership with Canada's key stakeholders in the industry. *Part 2 — Framework for Action* will be prepared in coming months, based on consultations with major industrial stakeholders, following study and review of the *Overview and Prospects*.

The **Sector Competitiveness Frameworks** series will focus on the opportunities, both domestic and international, as well as on the challenges facing each sector. The objective is to seek ways in which government and private industry together can strengthen Canada's competitiveness and, in doing so, generate jobs and growth.

In all, some 29 industrial sectors will be analyzed. *Part 1 — Overview and Prospects* will be available for distribution in printed as well as electronic forms during coming months for the following industries:

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Cat. No. C21-22/1-1-1996E
ISBN 0-662-24728-0

Aussi disponible en français sous le titre : Le génie-conseil : Partie 1 — Vue d'ensemble et perspectives.

FOREWORD

The new Canadian marketplace is expanding from national to global horizons and its economic base is shifting increasingly from resources to knowledge. These trends are causing Canadian industries to readjust their business approaches, and government must respond with new tools to help them adapt and innovate. Industry Canada is moving forward with strategic information products and services in support of this industry reorientation. The goal is to aid the private sector in what it is best qualified to do — create jobs and growth.

Sector Competitiveness Frameworks are a series of studies published by Industry Canada to provide more focussed, timely and relevant expertise about businesses and industries. They identify sectors or subsectors having potential for increased exports and other opportunities leading to jobs and growth. In 1996–97, they will cover 29 of Canada's key manufacturing and service sectors.

While they deal with "nuts and bolts" issues affecting individual sectors, the Sector Competitiveness Frameworks also provide comprehensive analyses of policy issues cutting across all sectors. These issues include investment and financing, trade and export strategies, technological innovation and adaptation, human resources, the environment and sustainable development. A thorough understanding of how to capitalize on these issues is essential for a dynamic, job-creating economy.

Both government and the private sector must develop and perfect the ability to address competitive challenges and respond to opportunities. The Sector Competitiveness Frameworks illustrate how government and industry can commit to mutually beneficial goals and actions.

The Sector Competitiveness Frameworks are being published sequentially in two parts. An initial *Overview and Prospects* document profiles each sector in turn, examining trends and prospects. The follow-up *Framework for Action* draws upon consultations and input arising from industry–government collaboration, and identifies immediate to medium-term steps that both can take to improve sectoral competitiveness.

CONTENTS

1 HIGHLIGHTS

The objective of this two-part examination of the consulting engineering industry is to help strengthen the competitiveness of Canada's consulting engineering sector and its ability to generate jobs and growth for Canadians. The focus of the document is on the international opportunities and challenges facing the industry.

Canada's consulting engineering industry contributes to the nation's wealth through innovation, design, and development of both industry and public infrastructure . . .

- Consulting engineers are skilled professionals who provide independent advice and a wide range of services normally associated with the development and implementation of capital projects.
- Canadian firms have traditionally had a competitive advantage in resource extraction, energy, telecommunications, transport and infrastructure engineering.
- Most Canadian consulting engineering firms are small, privately held and Canadian owned. A growing number are becoming international players.
- Canada's two largest firms, SNC Lavalin Inc. and AGRA Industries Limited, each have over 5000 employees world-wide. In terms of international billings, SNC Lavalin is ranked by *Engineering News Record*, a major U.S. industry journal, as sixth largest in the world in 1994, and AGRA as thirty-first.

The consulting engineering industry is at the leading edge of Canada's move toward a knowledge-based economy . . .

- The industry displays the unique characteristics of a business services industry and is at the leading edge in the movement toward the development of knowledge-based industries in the economy. This stands out clearly in a number of ways, including the way it organizes itself and its labour force.
- Consulting engineering firms are evolving toward a more flexible corporate structure, by maintaining core management and technical competency but relying on associates and specialists for extra help and special expertise during peak times.
- As with many "New Economy" industries, consulting engineering has strong links to other industries and its activities help those industries function more efficiently.
- The major competition facing consulting engineers comes increasingly from other domestic industries as boundaries between industries are dissolving. At the same time, consulting engineers are themselves developing new specialties.

Canada's consulting engineering sector ranks fourth largest in the world in terms of international billings . . .

- The United States dominates the global consulting engineering market because of its large domestic market and bilateral aid tied to donor-country sourcing. Other significant world players are the United Kingdom, the Netherlands, Germany and France.

- Canadian engineers have a reputation for honest evaluation that is trusted by their customers and the international financial community. A growing number of larger firms have the organizational capacity and the human and technological resources to compete effectively around the world.
- They are distinguished internationally by their success in providing consulting services such as design. However, they have been less successful in opening the way for Canadian suppliers to provide construction services, machinery, equipment and products.
- Globally, Canadian engineering companies compete with large, integrated, full-service firms or consortia. Canadian engineers need to strengthen their links to contractors, manufacturers, equipment suppliers and in some cases financial institutions and government agencies to generate the critical mass required to win the more profitable integrated projects.

Consulting engineering firms are key agents in the technology diffusion process . . .

- Consulting engineers promote technology diffusion by developing and using their own proprietary technologies in their project design and development work or by borrowing technologies developed elsewhere for use in projects they undertake. As a result, they transfer new technologies embedded in their projects to their clients.
- Few small firms have in-house resources to perform research and development (R&D) other than small-scale applied research in their specialized fields. Most engineering research is carried out through partnerships with universities, government laboratories, non-profit research centres and firms in other industries.

- Official R&D measures appear to understate the industry's contribution to national R&D, because of the difficulty in measuring much of the innovation that takes place on the job as part of the project development and implementation process.

1.1 Major Trends

Evolving markets are giving rise to significant challenges . . .

- Significant growth opportunities in the domestic market in the medium term appear limited to the engineering specializations discussed below under "New specializations and skills are required," but opportunities in world markets are enormous. Many of these opportunities are in areas of the Canadian industry's traditional strengths.
- Increasing numbers of capital projects are being completed in design-build, turnkey and varying configurations of build-own-operate-transfer (BOOT). Too few Canadian firms have such capabilities and therefore have not traditionally been very successful in securing such integrated projects. New privatization initiatives by the different levels of government in Canada will provide opportunities to further develop this capacity.
- Those able to transform from a pure engineering to a full-service approach will be in a position to tap into extremely large and rapidly growing international markets. Achieving this will require the development of more effective partnerships and alliances to form consortia capable of taking on and financing major BOOT-type projects.

- Canadian consulting engineers will find significant additional opportunities in global markets. Contributing factors are growing environmental needs, political changes especially in eastern Europe, the North American Free Trade Agreement, privatization of infrastructure projects, and continuing strong economic growth in Latin America and the Pacific Rim.
- Particularly key are the opportunities arising from the global movement toward infrastructure privatization, especially in the less developed countries.

Access to financing needs to be improved . . .

- The ability to obtain financing is key to capturing more of the proliferating BOOT-type projects. The Canadian industry will have to develop more innovative financing arrangements and more effective partnerships with financial institutions.
- The major obstacles to both domestic and foreign private financing of integrated projects are the inability of many firms to obtain unencumbered financial leverage, their weak profitability and shortage of in-house multidisciplinary skills.
- Canada is not as successful in winning projects financed by international financial institutions (IFIs), like the World Bank, as are other member countries of the Organisation for Economic Co-operation and Development.

New specializations and skills are required . . .

- Consulting engineers able to strengthen their capabilities in advanced manufacturing technologies, systems integration and environmental technologies will be better positioned to tap into new domestic and international markets.

- Despite the involvement of one third of members of the Association of Consulting Engineers of Canada (ACEC) in service exports, only 10% of overall firm revenue comes from exports. Although many more Canadian engineering firms appear to be export ready, they have yet to take the plunge.
- Consulting engineers are increasingly being required to integrate new capabilities into their operations. In addition to advanced technical and computer skills, both young graduates and engineers already in the work force need more sophisticated training in project planning, financing and operating, as well as marketing and image building.

1.2 The Bottom Line

The following major issues must be addressed by government and the industry working together:

Trade

- Firms need to provide the full range of services associated with design-build, turnkey and BOOT-type projects to win contracts and capture the benefits of downstream business. Success in the future will depend on placing greater emphasis on consortia building based on linkages with a number of key sectors, including the financial sector.
- Given the domestic market outlook, success must be achieved in international markets, particularly in Asia and Latin America, for both IFI and privately funded capital projects, including infrastructure privatization projects.

- A greater number of firms in the industry need to become export oriented in order to take advantage of growing international opportunities.
- Canadian financial institutions must play a stronger role in international project financing.
- The government must achieve a more strategic coordination of its programs and services in support of the international business development interests of the industry.

Human Resources

- Firms must develop new human resources capabilities to strengthen their expertise in new areas of specialization.
- Consulting engineers adopting life-long learning will better retain their competitive skills advantage in domestic and international markets in areas such as technical skills, project management, marketing, business and financial management, and entrepreneurial skills.

Environment

- Consulting engineers must make sustainable development an integrated component of the engineering services they offer.

Technology

- Initiatives are required to strengthen the capabilities of consulting engineering firms in areas such as advanced manufacturing technologies, geomatics, systems integration and environmental technologies in order to offer new consulting services in market growth areas.

- Stronger links are needed between the industry and centres of excellence to ensure more effective technology transfers.

By meeting these challenges, the Canadian consulting engineering industry can maintain its importance in the domestic economy and improve its performance in rapidly growing international markets for capital projects.

2 KEY POINTS ABOUT THIS INDUSTRY

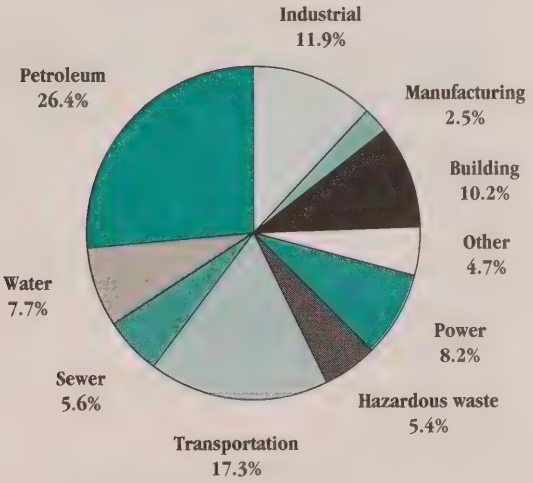
2.1 Global Context

Consulting engineering is a profession that provides independent advice and a wide range of services normally associated with the development and implementation of capital projects. Specialized fields within the sector include mechanical, civil, electrical, chemical and computer engineering activities and technologies. Professionals in these occupations develop and use many leading-edge technologies, particularly information technologies, in the move toward a global information society.

The top 200 international consulting engineering firms in 1994 performed work on projects outside their own countries worth C$13.5 billion, according to *Engineering News Record* (ENR), a major U.S. industrial journal (Figure 1).

1994 foreign billings by top 200 design firms reached C$13.5 billion

Figure 1. Amount of Work Performed in Various Industrial Sectors by the Top 200 International Engineering Design Firms, 1994



Source: *Engineering News Record*, July 24, 1995.

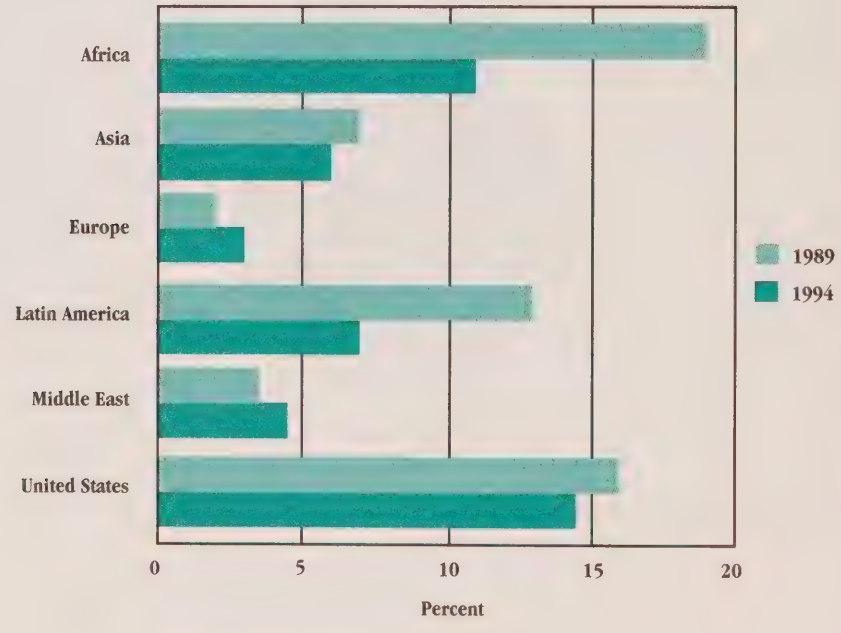
U.S. dominates global consulting engineering markets

The United States dominates the global market for consulting engineering, according to ENR. In 1994, U.S. firms accounted for 31.5 percent of international billings. Its large domestic market fosters world-class expertise with leading-edge technological capabilities for international projects, while its funding for bilateral foreign aid projects is largely tied to domestic sourcing. The U.S. consulting engineering sector, with roughly 35 600 firms and C$50 billion in total sales in 1988, is the world's largest in terms of domestic and international work combined, according to an Industry Canada study (*A Competitive Overview of the Canadian Consulting Engineering Industry*, Industry Canada, February 1994).

Canada supplied 6% of 1994 global exports of consulting engineering services

Canadian design firms supplied 6 percent of the 1994 global exports of consulting engineering service. While there was a decline in the Canadian share of world consulting engineering services imported by Africa, Asia, the United States and Latin America between 1989 and 1994, the Canadian share of work in the Middle East and Europe increased (Figure 2). Moreover,

Figure 2. Canadian Share of Imported Engineering Design Services, Selected Countries, 1989 and 1994



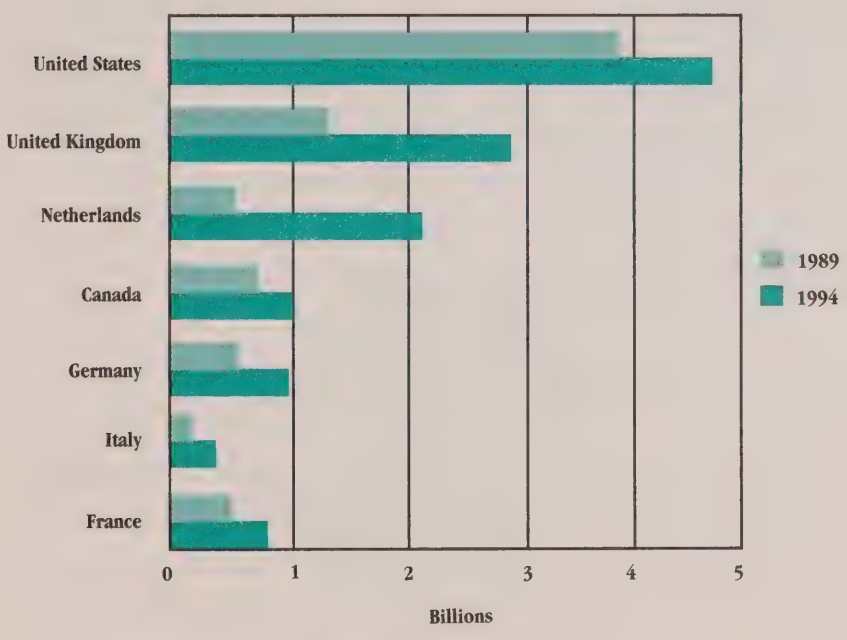
Source: ENR, July 24, 1995.

although the Canadian export shares to both the United States and Asia declined, the dollar value of Canadian engineering exports to both of these large and important markets increased significantly during the period.

Canadian firms in 1994 ranked fourth in total international billings in consulting engineering (Figure 3). Other countries whose consulting engineering firms had significant shares of international billings were the United Kingdom and the Netherlands. German competitors are increasing their presence in the international market, and threaten to rival Canada's exports in consulting engineering services. Firms from France and Italy are not far behind.

Canada's ranking in international billings slid from 2nd place to 6th, rebounded to 4th, but is threatened by Germany and France

Figure 3. Nations Leading in International Billings Among the Top 200 International Engineering Design Firms



Source: ENR, July 24, 1995.

Canada's strengths: resources, energy, infrastructure

In international markets, Canadian firms exhibit particular expertise in power and industrial/petroleum projects, according to ENR. Firms in the Netherlands focus particularly on water projects such as dams, reservoirs, canals, tunnels, mains, treatment plants, pumping stations, etc., and they compete with Canada and the United States for transportation projects like airports, bridges, dredging, marine facilities, railroads, subways, etc. French firms report a similar emphasis on water and transportation projects. (For more information on Canada's competitors in engineering services, see Annex B.)

"Countries such as Chile, Argentina and China are opening up their marketplaces to the private sector." — Bill Pearson, President, AGRA Industries Limited

Canadian companies are taking increasing advantage of global opportunities in both developed and developing countries as well as in transitional economies like Russia and eastern Europe.

While global opportunities for Canadian consulting engineering firms are expanding, so are the risks and uncertainties. The opportunities and risks demand strategic assessment of the potential for repeat business for specialty services and also for long-term penetration of client-country markets.

2.2 North American Context

Canada's 1994 share of U.S. market: 15%

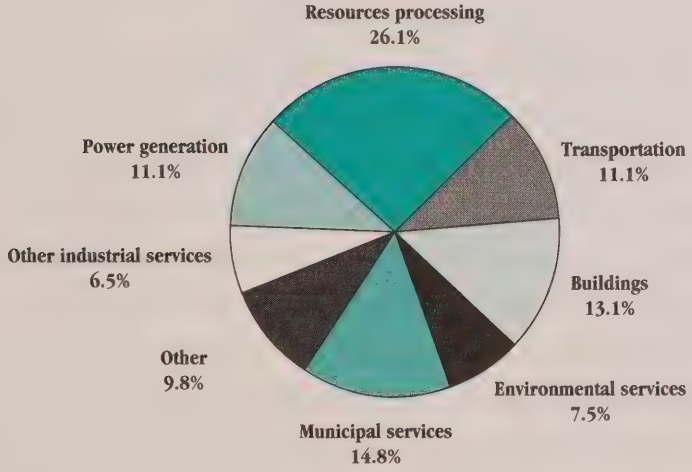
Canada's share of the large U.S. market remained at about 15 percent in 1994, according to ENR data. This was about the same level as before the North American Free Trade Agreement (NAFTA) was signed by Canada, the United States and Mexico in 1992. Despite provisions in NAFTA for enhanced access into each other's domestic markets, the penetration by Canadian firms into the U.S. public sector is limited by a number of non-tariff barriers. The Mexican market, however, is expanding with an accelerated infrastructure program.

2.3 Canadian Industry Snapshot

Consulting engineers design all types of industrial installations, public works, large private and public buildings, and transportation systems (Figure 4). Public infrastructure encompasses power generation and transmission projects as well as municipal services like roads, streets, water supply, and sewage systems and treatment. Industrial services involve support to resource extraction and also to all types of refining and manufacturing. Resource-based work entails pulp and paper manufacture, mine development, and oil and gas extraction, refinement and distribution. Other areas of business include telecommunications infrastructure design, marine works, transportation and the environment. (For more information on engineering services and industry models, see Annex A.)

"Engineers represent an important aspect of wealth creation . . . helping industry to be competitive."
— Stanley Kubina, Associate Dean of Engineering, Concordia University

Figure 4. What They Do: Sources of Annual Revenue of Canadian Consulting Engineering Firms, 1992
(Total = $5.6 billion)



Source: Statistics Canada survey of engineering and scientific services, March 1996.

Engineering design work is split between private and public sectors

Engineering design work in Canada is split roughly between the private and public sectors. The major public sector clients are provincial and municipal governments.

Canadian resource and infrastructure markets are mature

The Canadian industry's traditional strengths lie in natural resource development and infrastructure construction. These markets are considered relatively mature. Meanwhile, increasing and long-term fiscal restraint by governments at all levels is leading them to privatize public infrastructure and, in doing so, open up new private sector opportunities. In the process, the firms involved also gain opportunities to transfer experience in public infrastructure design and implementation to developing international markets.

Size of industry: 65 000 people in 6424 firms

Statistics Canada estimates 1992 employment in the Canadian consulting engineering industry at about 65 000 people in 6424 firms. Total billings amounted to approximately $5.6 billion in the same year. [The statistics used throughout this report are the latest available as of June 1996. Although ENR provided valuable current data, the more reliable Statistics Canada data are often available only with a significant time lag.]

Most Canadian consulting engineering firms are small

Most Canadian consulting engineering firms are privately held and Canadian owned. Most firms employ fewer than 50 people. The average Canadian consulting engineering firm in 1991 employed 13 people, compared with 17 in U.S. counterparts. The 1994 Industry Canada study cited earlier indicates that each employee generated about $74 000 on average for the firm in Canada in 1989, compared with $84 000 in the United States. Most Canadian firms earned less than $250 000 annually. While Canadian firms averaged about two thirds the revenue of American firms, their overhead and employee costs were also lower. As a result, Canadian and U.S. firms achieved comparable profitability. Relative to firms in the Netherlands and France, average revenue per Canadian establishment was similar, whereas costs were lower in Canada.

While the sector continues to be fragmented, a trend toward consolidation has emerged recently among both smaller and larger companies. Large firms merge to take on international projects, and smaller ones are created by specialists coming onto the market as a result of downsizing among their former employers.

Increasing consolidation is creating new firms

Through their calls for bids, Canadian consulting engineers can create major domestic and global sales opportunities for Canadian suppliers, manufacturers and construction firms. Such linkages throughout the economy have a multiplier effect on Canadian employment and income. Factors affecting the multiplier include financing source, project location and size as well as Canadian ability to supply and export the required equipment and materials. (Industry Canada is commissioning a study to assess industry impact on the Canadian economy and to identify key multipliers; results are expected to be released soon.)

Many linkages to the larger economy

The industry is comprised of publicly and privately owned firms and sole proprietors. About half of the demand for engineering services in Canada is met by specialized design firms. Most of the remaining demand is satisfied by the in-house engineering staff of the corporations undertaking the projects.

Canadian market divided between consultants and in-house staff

The distribution of public versus private sector demand over time is influenced by the economic cycle, capital investment and, especially during the 1990s, government policy such as cutbacks in public sector spending. Fiscal restraint facing large employers in both the private and public sectors has affected consulting engineering through employment reductions and reduced demand for office space. More recently, infrastructure budgets have been curtailed. In turn, private and public utilities and some Crown corporations are

Downsizing offers opportunities for private sector firms

facing increasing competition, and so are turning to staff reductions and outsourcing to reduce input costs. The result is having a mixed effect on consulting engineering. On the one hand, this trend is shifting demand for engineering services toward private sector consulting firms. On the other hand, governments at the federal, provincial and municipal levels may allow outplaced staff to compete publicly with established consulting engineers, a practice the latter view as unfair competition.

Firms are important agents for diffusing technology and best practices

Other regulatory matters are not a major issue for this industry. The industry is supportive of environmental regulations, and views participating firms as important agents for diffusing environmental technology and best practices.

International agreements improve access to markets

International policy is another factor influencing the amount of public sector business that consulting engineering firms perform. NAFTA contains provisions regarding government procurement practices involving private firms in the partner countries and also sets service obligations. Further negotiations have led to a mutual recognition agreement for architects and engineers as well as for scientific services. NAFTA provides for the competitive tendering of federal engineering and scientific services contracts for both Canada and the United States. In addition, NAFTA as well as international agreements signed under the umbrella of the World Trade Organization (WTO) contain provisions for improving access by firms of one member nation to the domestic markets of other signatories.

Canada's top two global consulting engineering firms:
SNC Lavalin
AGRA Industries

A growing number of Canadian firms are becoming international players. In 1994, Canadian-based SNC Lavalin Inc. was sixth largest in the world in terms of billings, and AGRA Industries Limited was thirty-first, ENR reports. SNC Lavalin and AGRA each have more than 5000 employees worldwide. Over the past ten years, both firms have grown through amalgamations

and mergers. In January 1996, SNC Lavalin strengthened its mining sector position through the purchase of Kilborn Holdings Inc., thus creating one of the strongest mining and metallurgy companies in the world. AGRA has grown from primarily a food processor to a large, integrated consulting engineering firm with wide-ranging interests and skills. Specialties encompass geographical information systems and software development. Both SNC Lavalin and AGRA are now positioned to manage or take part in project financing substantially beyond their capacity five or ten years ago.

Other Canadian firms listed by *Engineering News Record* in the top 100 international engineering design firms in terms of foreign billings in 1994 include H. A. Simons Ltd. (35th), Golder Associates Ltd. (40th), Sandwell Inc. (50th), Tecsult Inc. (73rd) and Acres International Ltd. (94th).

Ownership concentration in the industry is low: the top 80 firms together earn 35 percent of industry revenues. By way of comparison, in some manufacturing sectors such as automotive assembly, 35 percent of industry revenues are shared among fewer than four top firms.

Low ownership concentration means many firms share in the work and rewards

Canadian consulting engineering firms and employees are distributed regionally according to natural resources sites, industrial locations or urban centres. British Columbia firms, for example, have developed particular expertise from working in the forestry and pulp and paper industries in that province. Alberta firms similarly specialize in oil and gas. Saskatchewan and Manitoba firms have strengths in agriculture and agriculture-based industry as well as in uranium and potash mining. Quebec firms deal extensively in hydro-electricity production. Ontario and Atlantic firms are more evenly distributed among the disciplines, with some concentration in municipal services and building construction.

Regional specialties:
B.C.: forestry
Alberta: oil and gas
Sask. and Man.: agriculture, mining
Quebec: hydro
Ontario and the Atlantic provinces: general

Ontario and Quebec firms earn two thirds of industry revenue

A major consulting engineering base developed in the Ontario–Quebec industrial heartland accounts for about two thirds of the industry's total fee income. Some 37 percent of the industry's total revenues in 1992 were earned by Ontario firms, 27 percent by those in Quebec, followed by B.C. firms with 17 percent and Alberta firms with 13 percent. Remaining revenues were evenly distributed among firms in the remaining provinces proportionate to population. The larger consulting engineering firms are active in all regions of Canada.

"The product coming out of the universities has to be trained differently. Besides basic engineering, a consulting engineer also has to learn interpersonal skills and be more of an all-round person."
— Oskar Sigvaldason, President, Acres International Ltd.

The Canadian Council of Professional Engineers (CCPE), through its provincial associations, is responsible for the licensing of professional engineers. Consulting engineers are represented by the Association of Consulting Engineers of Canada (ACEC), of which approximately 750 of Canada's largest engineering firms are members. Nearly a third of ACEC members operate in both domestic and international markets.

Despite the involvement of one third of ACEC member firms in exporting engineering services, their foreign billings yield only about 10 percent of overall firm revenues. In comparison, both computer services and scientific research earn larger revenue shares in exports than does engineering. Many more Canadian engineering firms appear to be "export ready," and could generate considerably higher export revenues once they have become so.

Professional engineers enjoy freedom of movement

In November 1994, professional engineers achieved Canada-wide mobility through an agreement signed by the 12 member associations of the CCPE. With this agreement, a professional engineer who is a member in good standing (for at least five years) with any of the 12 regulatory associations will be recognized by all. However, to work in another province or territory, consulting engineers must become a member of that jurisdiction's association.

Industry human resources studied by HRDC

A major study of industry human resources, including skill requirements, was conducted recently by Human Resource Development Canada (*From Potential to Prosperity: Human Resources in the Canadian Consulting Engineering Industry*, HRDC, November 1994). The following recommendations emerged:

- The industry needs to adopt a corporate culture that values increased teamwork and employee empowerment, and supports continuous learning and adaptation to meet changing customer needs and to build successful business relationships.
- Firms need more participative, non-traditional organizational forms. Firms and individuals also need to develop and maintain technical, business, marketing and financial management skills.
- A stronger infrastructure for continuing education, including agreement on how to fund training, is needed. *Ad hoc* and technical training need to be supplemented with "soft skills" training such as teamwork and communications, and business skills, with reimbursement for employees who successfully complete external courses.
- Responsive compensation and reward systems such as profit-sharing, ownership participation and results-based incentives are needed, as well as remuneration comparable with that of engineers in other sectors.
- The industry image should be improved to demonstrate potential value-added.

The ACEC has hired a human resources coordinator to address these issues and to implement the report's recommendations through various training modes.

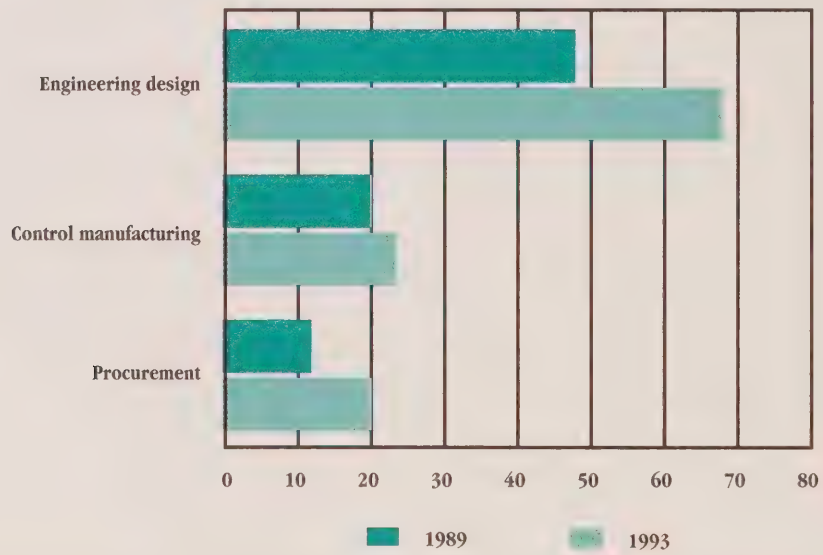
"Companies require more and more specialized engineers: the whole economy is demanding more highly trained people."
— Andre Bazergui, Director, École Polytechnique, University of Montreal

Advanced technologies are used in consulting engineering firms to create value for clients by improving quality or reducing the costs of design, construction and operation. These innovations fall into four basic categories: automation, project management and construction techniques, technological expertise and proprietary processes. (For more information on forms of innovation, see Annex C.)

Integrating manufacturing is a market opportunity

Created and used by consulting engineers, computer-aided design and drafting (CADD), computer-assisted engineering design (CAED) and engineering technology play important roles in Canadian manufacturing shipments. The dynamic proliferation of these design and engineering technologies in Canada between 1989 and 1993 is portrayed in a 1993 Statistics Canada survey of about one third of Canadian manufacturers (Figure 5). Titled *Technology Adoption in Canadian Manufacturing*

Figure 5. Increasing Use of Advanced Technologies by Canadian Manufacturers, as a Percentage of Shipments, 1989 and 1993



Source: Statistics Canada, *Technology Adoption in Canadian Manufacturing*, Catalogue No. 88-512, 1993.

(Statistics Canada Catalogue No. 88-512), the report reveals that technologies for product design are considerably more prevalent than those for control manufacturing or procurement. The results suggest considerable opportunity for consulting engineers in the years ahead when larger manufacturing companies become ready to move into integrated manufacturing (although the sample did contain twice as many large establishments as small ones).

Most manufacturers use one or more advanced technologies

The survey findings reveal that over 81 percent of total manufacturing shipments are made using at least one advanced technology: 73 percent use one in communications and inspection, 63 percent use one in product design and 53 percent use one in information systems. Yet fully integrated factories account for only 8 percent of shipments. Moreover, firms with over 500 employees are three times more likely to adopt certain technologies than establishments with fewer than 20 employees. In fact, only the large establishments combine to any extent technologies such as design, engineering, fabrication and assembly. Ontario establishments at 86 percent exhibit the highest advanced technology use, compared with 77 percent in the Prairies, 76 percent in Quebec, 66 percent in British Columbia and 65 percent in the Atlantic provinces.

Engineering (including other scientific services) does 9% of all industrial R&D

Business services research and development (R&D) accounts for about 15 percent of total R&D performed by businesses in Canada. This figure has grown substantially over the past 15 years, especially in engineering and other scientific services, followed by computer services. In 1994, the latter two categories jointly accounted for 84 percent of total business services R&D expenditures. In terms of total industrial R&D, the share is much smaller. Engineering and other scientific services account for 9 percent, while computer services account for about 5 percent. Examples of direct and indirect R&D undertaken by Canadian consulting engineering firms include SNC Lavalin's oil from sludge process technology, Monenco AGRA's Project Management System, and Associated Engineering's start-up companies in computer software, mining and ethanol fuels from waste.

Universities, NRC, non-profit research centres and other industry sectors do engineering R&D

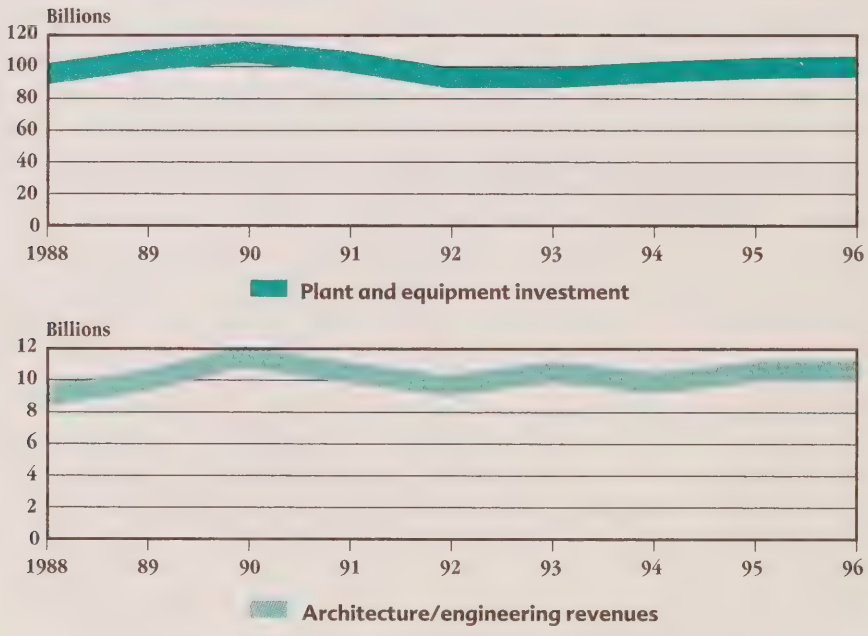
The small size of most consulting engineering firms affords them few resources to perform R&D other than small-scale applied research in their specialized fields. Software development is one example. Such programs are used for marketing as well as for raising revenues. While not formally recorded among official R&D statistics, much innovation takes place on the job as part of project delivery, and may make a substantial contribution to national R&D. Most engineering research is carried out in partnership with universities, government laboratories (specifically the National Research Council of Canada (NRC)) institutes, non-profit research centres and other private industry sectors.

2.4 Performance and Competitiveness Factors

Profitability closely tied to economic cycle

Industry billings, operating profits and operating revenues parallel the economic cycle (Figure 6).

Figure 6. Congruity between Revenues for Architecture and Engineering, and Manufacturing Plant and Equipment Investment

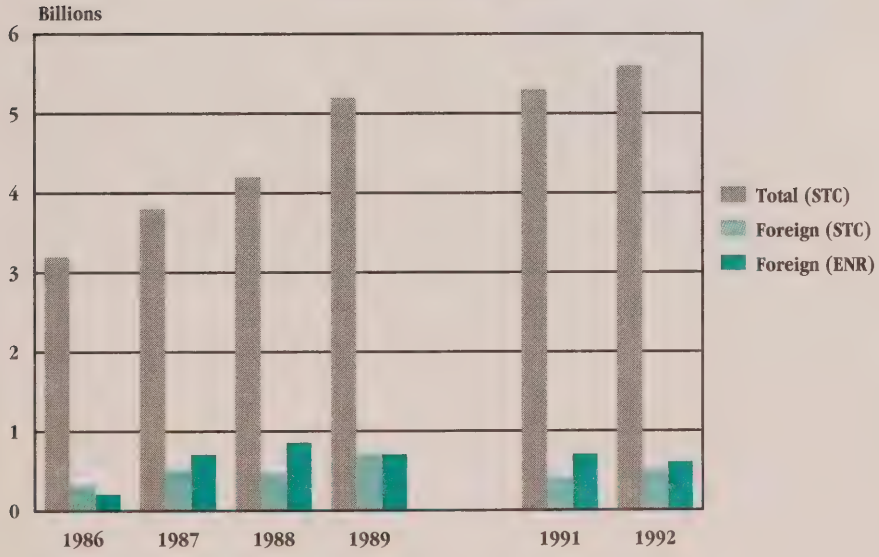


Source: Statistics Canada — Service indicators (custom tabulation for Industry Canada), 1995.

This congruence is demonstrated in industry data for 1989–92 taken from Statistics Canada surveys of consulting engineering firms, and more recent but broader financial data on architects, engineering and scientific services. The broader category is used as a proxy for the lack of recent data for consulting engineering alone. A special run back to 1988 shows revenue growth rates significantly lower for architects, engineering and scientific services than for consulting engineers alone. Between 1988 and 1991, billings for consulting engineering alone grew by 25.2 percent, compared with 17.4 percent for architects, engineering and scientific services, suggesting that, if anything, the proxy is conservative.

Total consulting engineering billings increased rapidly by $2.1 billion between 1986 and 1989 from $3.1 billion to $5.2 billion (Figure 7). Then growth slowed between 1989 and 1991, reaching $5.6 billion in 1992. The slowdown coincided with the onset of recession in the business cycle beginning in 1990. While overall financial health was not strong through the recession, some individual firms were highly successful.

Figure 7. Continuing but Slowing Growth in Consulting Engineering Billings[a]



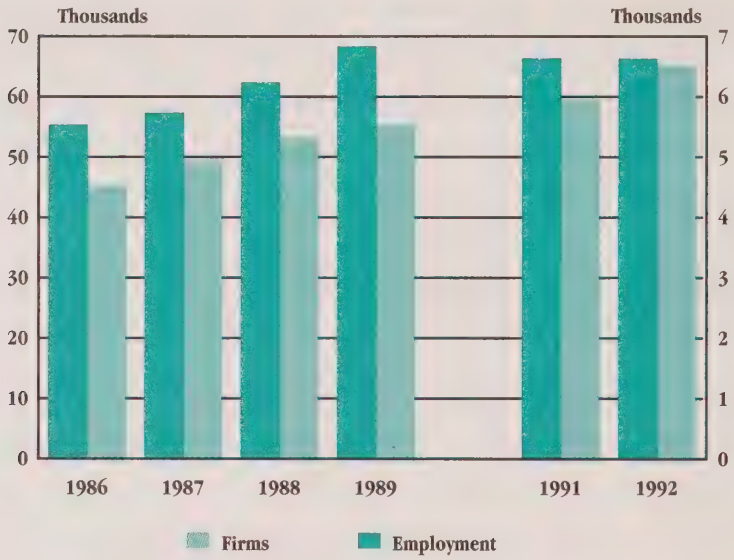
[a] Statistics Canada did not undertake a survey in 1990.

Source: Statistics Canada (STC) survey of engineering and scientific services, March 1996; ENR, July 26, 1993.

Layoffs, downsizing lead to increase in new firms

The number of Canadian firms rose between 1989 and 1992 by about 800. Most of this increase probably reflects specialist firms started by people laid off through downsizing (Figure 8).

Figure 8. Growth in Firms and Total Industry Employment[a]

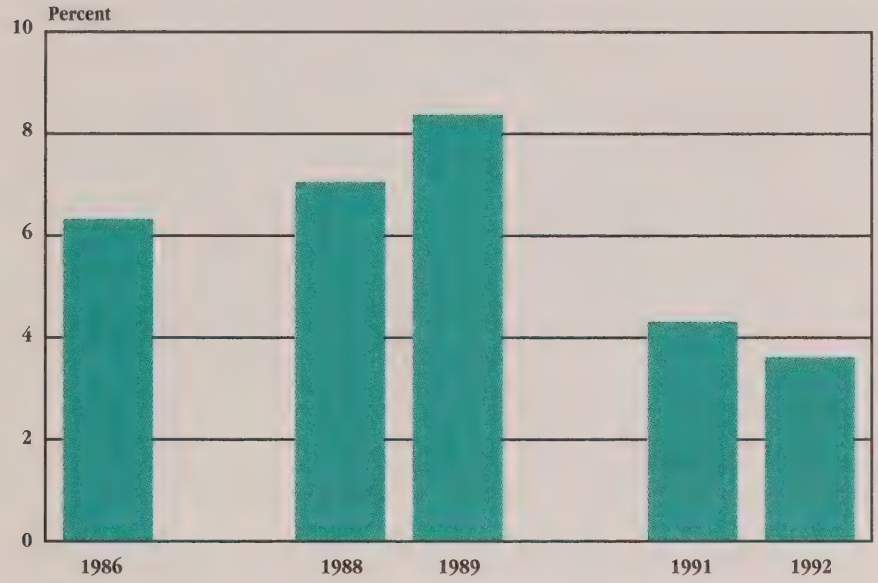


[a] Statistics Canada did not undertake a survey in 1990.

Source: Statistics Canada survey of engineering and scientific services, March 1996.

In line with stagnation in billings coinciding with the onset of the early 1990s recession, operating (pre-tax) profit margins were 6.4 percent in 1986, 8.4 percent in 1989 and 3.6 percent in 1992 (Figure 9).

Figure 9. Falling Operating Profit Margins Among Consulting Engineers[a]



[a] Statistics Canada did not undertake a survey in 1990, and data are not available for 1987.

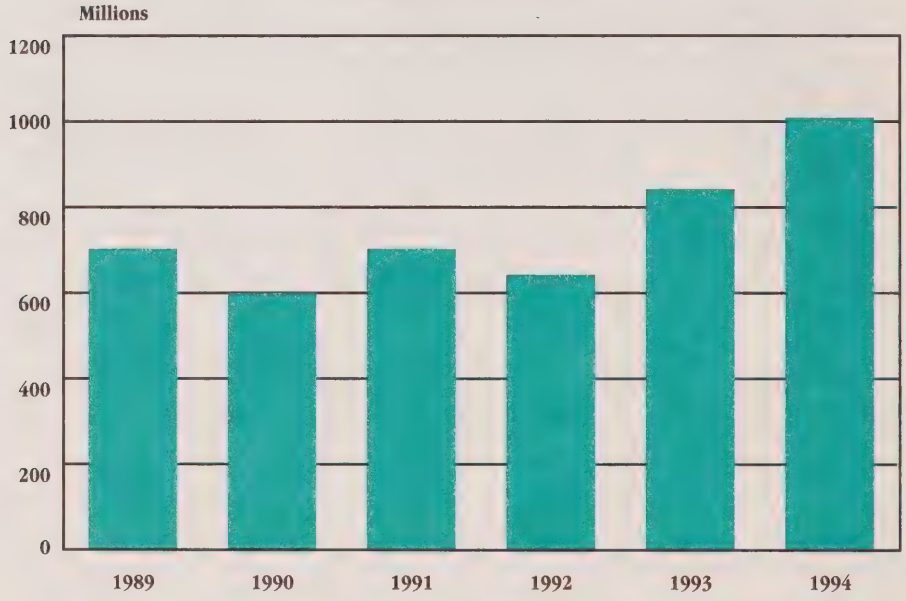
Source: Statistics Canada survey of engineering and scientific services, March 1996.

Trade performance data for consulting engineering are collected by Statistics Canada as part of a larger category embracing consulting and other business services. (Data for the larger set are more recent than for consulting engineering alone.) While this larger category is not a precise indicator of exports of consulting engineering services alone, over time they form the largest component of business services exports.

Canadian 1994 trade balance in consulting engineering healthy

Statistics Canada data show that $1.45 billion worth of business services were exported in 1993, which represents a 4.9 percent annual growth rate since 1981. Business services imports, on the other hand, stood at $1.02 billion in 1993, for an annual average growth rate of 3.9 percent from 1981 to 1993. The net result is an annual trade surplus for Canada in this sector since 1981. Other unofficial but respected sources confirm a strong trade performance by Canadian consulting engineering. According to ENR, Canadian consulting engineering firms earned $1 billion in foreign countries in 1994, while foreign billings in Canada for consulting engineering amounted to $366 million (Figure 10).

Figure 10. Rising International Billings of Canadian Consulting Engineering Firms

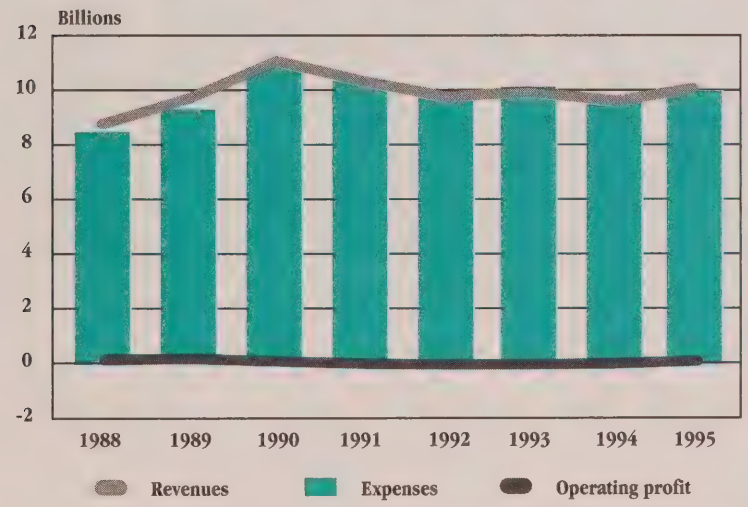


Source: ENR, July 24, 1995 (converted to Canadian dollars by Industry Canada).

However, viewing the rate of growth rather than the level indicates a different picture. While foreign billings for Canadian firms between 1989 and 1994 show strong growth during the latter part, they posted almost no increase during the first part. Germany and France, on the other hand, had growth rates exceeding that of Canada between 1989 and 1994, and could threaten Canada's current fourth-place position in total international billings in consulting engineering.

The Statistics Canada broad financial data on architects, engineering and scientific services reveals that their operating revenues trended down between 1990 and 1994, despite a slight improvement in 1993 (Figure 11). By 1995, they had recovered to 1991 levels. Similarly, their net profits were negative from 1990 to 1994 and positive in 1995.

Figure 11. Loss and Recovery in Revenues, Expenses and Operating Profits Among Architects, Engineers and Scientific Services

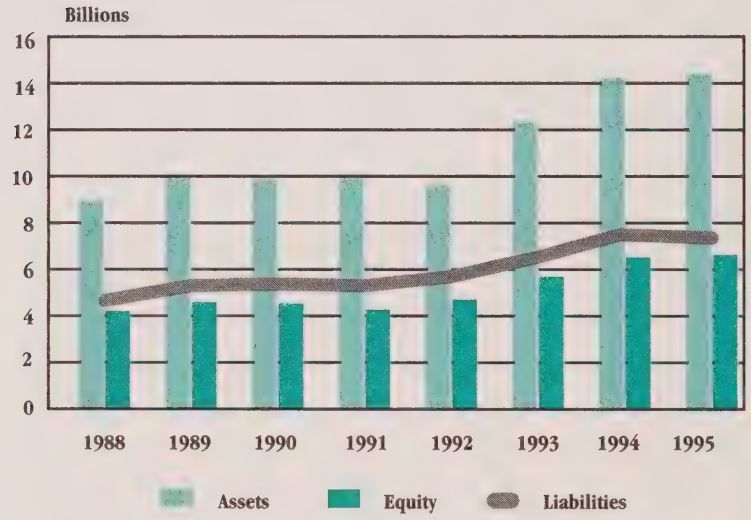


Source: Statistics Canada — Service indicators (custom tabulation for Industry Canada), 1995.

Asset base of architects, engineers and scientific services increased despite negative profits during recession

Despite the negative profits during the recessionary years, the asset base of architects, engineers and scientific services continued to grow, illustrating continued structural change (Figure 12). Between 1992 and 1995, assets of large firms increased by more than 50 percent, reflecting a commitment to upgrading their facilities, particularly communications infrastructure, and to diversifying their capital base. Large firms increased their holdings of buildings, other physical plant and subsidiaries, and adopted more advanced technologies, leading to computer and software purchase. New start-ups and public offerings by large firms produced shareholder capital, which was the main financing source for this growing asset base.

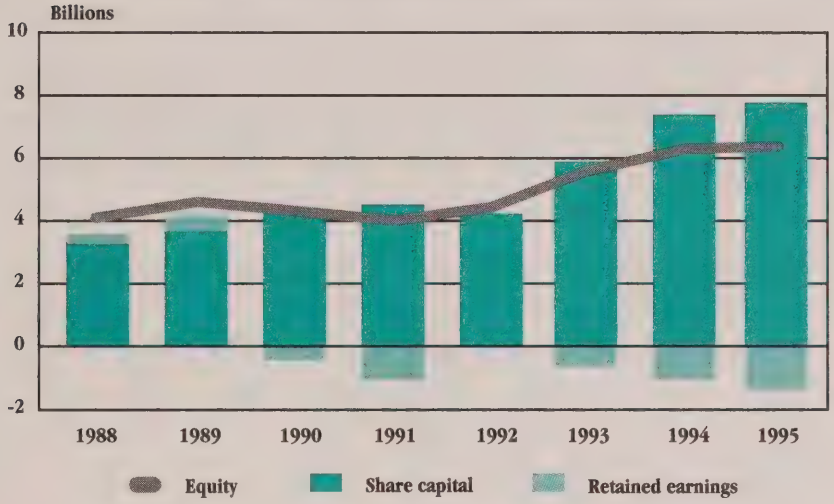
Figure 12. Continuous Growth in Assets, Equity and Liabilities of Architects, Engineers and Scientific Services



Source: Statistics Canada — Service indicators (custom tabulation for Industry Canada), 1995.

Aside from 1992, retained earnings were also negative during the early 1990s, in part because of large numbers of partnerships in the profession and a high propensity to distribute profits and dividends (Figure 13).

Figure 13. Fluctuation in Share Capital and Retained Earnings[a] of Architects, Engineers and Scientific Services



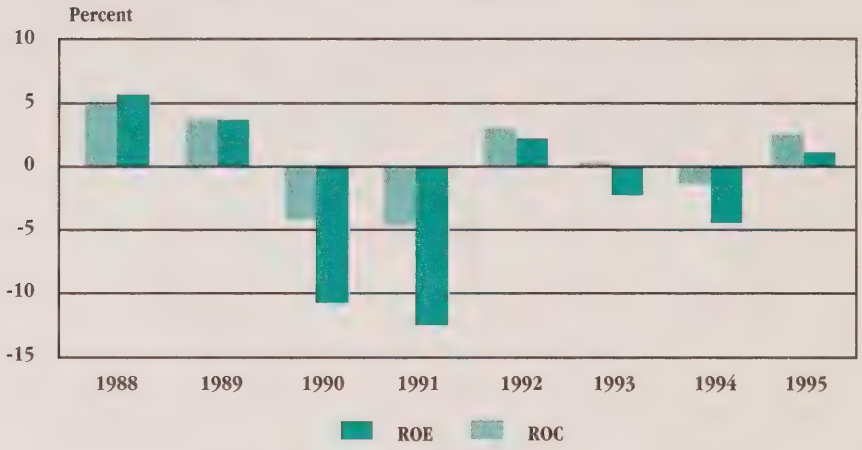
[a] Retained earnings is the difference between share capital and equity.

Source: Statistics Canada — Service indicators (custom tabulation for Industry Canada), 1995.

Shareholder capital main financing source since recession

Between 1988 and 1995, the industry overall failed to keep pace with returns on relatively risk-free, long-term Canada bonds (Figure 14). This low return rate partially explains the industry's most recent investment intentions, as gathered by Statistics Canada, which forecast declining capital investment from $415.6 million in 1995 to $341.5 million in 1996, primarily in machinery and equipment.

Figure 14. Depressed Rates of Return on Capital (ROC), Including Loans and Total Equity and Return on Equity (ROE)



Source: Statistics Canada — Service indicators (custom tabulation for Industry Canada), 1995.

"Honesty and personal integrity [are] more important than your bank account. . . . It is important to have perseverance and never give up."
— Guy Saint-Pierre, Former CEO, SNC Lavalin Group Inc.

Canadian firms are renowned worldwide for their state-of-the-art expertise and their ability to adapt to and operate within unfamiliar cultures and constraints. Many firms are multilingual. Canadian engineers have a reputation for honest evaluation that can be trusted by the international financial community. Marketed properly, these attributes can create opportunities for the Canadian industry.

Canadian engineers and architects are among the most cost-effective in the world, according to a survey of industry practices by ENR (March 27, 1995). Their professional fees were the second lowest, at just 6.75 percent of a typical project value comprising the full design and construction services. At the high end were design engineers in Mexico (12 percent) and the United Kingdom (14 percent).

Globally, Canadian consulting engineering companies compete with large, integrated, full-service firms or consortia, which are often linked to contractors, manufacturers, equipment suppliers, and in some cases financial institutions and government agencies. These competitors possess the critical mass and financial resources to engage in design-build, turnkey, build-own-operate-transfer (BOOT) and other forms of integrated projects. (For a review of Canada's chief international competitors, see Annex B.)

"[Engineers] have to start networking with other engineering firms and find those they can work with to focus on international markets."
— Keith Robinson, Chair, ACEC

3 CHANGING CONDITIONS AND INDUSTRY RESPONSE

3.1 Investment and Financing

"Governments don't have the money, but they do have the need. So they want to shift the financial issue to the private sector."
— Bill Pearson, President, AGRA

The international capital market is primarily shaped by three driving forces:

- privatization
- competition for scarce risk capital
- rising competition for both new and replacement infrastructure projects.

Governments facing fiscal cutbacks are turning to privatization of Crown assets and agencies to fight debilitating deficits. The extent to which privatization is encouraged by governments contributes directly to the ability of goods and services firms to export this experience. This approach was first adopted in the United Kingdom, France, the United States, Argentina, Chile and Malaysia, and is now being widely endorsed as an important feature of economic policy in many other countries as well.

Infrastructure privatization activities in Canada have not been pursued to the same degree as in other countries. Therefore, Canadian corporate experience cannot be built to the same degree from domestic activities. The larger Canadian consulting engineering firms are developing more innovative approaches, consolidating their operations and adapting to the changing global economic environment. For example, Canadian privatization projects in the transportation sector such as Highway 407 north of Toronto will benefit consulting engineering firms, who can export this Canadian experience overseas.

The challenge is for medium-sized and smaller consulting engineering firms to operate efficiently and effectively in this environment as well. Companies able to arrange creative financing packages with banks and other financial institutions, governments and private investors will undoubtedly be more successful.

Private sector financing encourages engineering firms undertaking integrated projects to minimize their construction-phase carrying costs to avoid building excess capacity and to establish firm operating revenues. User fees or tolls are often set for large engineering projects in the face of increasing public sector restraint, as is the case for the Highway 407 project. Creative financing can include the use of supplier and export credits, foreign government guarantees, multilateral development bank financing, bilateral aid tied to donor-country suppliers, and countertrade.

"When banks look at the feasibility of a project, they also look at the records of the companies involved in it."
— Stephan Simek, President, Ferguson Simek Clark

Risk capital availability for infrastructure projects will be determined by the rewards and incentives set by governments and utilities, the extent of conversion to BOOT-type capacity and consequent cost savings, and the ability of consulting engineers to forge links with capital markets and manage their portfolios. One avenue in which Canada is less successful than other member countries of the Organisation for Economic Co-operation and Development (OECD) is funding through international financial institutions (IFIs) such as the World Bank. Under IFI financing, the World Bank group and the regional development banks provide $40 billion annually for project financing, which is matched by borrowing countries and financiers.

Canada lags OECD in landing IFI contracts

3.2 Trade

Limits to cross-border access by consulting engineers are still prevalent, despite provisions in the NAFTA to ease restrictions. Canadian consulting engineering firms are frequently unable to bid on U.S. national and state government contracts because of:

On paper, NAFTA opens up U.S. government procurement but some barriers remain

- national security exclusions
- state and provincial licensing and accreditation requirements
- application of U.S. "Buy America" preferences to major federally funded infrastructure projects
- U.S. small business and minority set-asides, together with subcontracting conditions favouring small and disadvantaged businesses.

American, Canadian and Mexican engineers have signed a licensing agreement to accredit engineers from partner countries. However, Canadian firms selling services into the U.S. currently deal with these issues by sub-contracting rather than acting as primes. Alternatively, larger firms operate through U.S. subsidiaries or related companies as market entry points.

3.3 Human Resources

Consulting engineering firms are altering their hiring practices by shifting toward short-term employment contracts on a job-by-job basis. This is referred to as the "Hollywood model," because, as in film production, firms maintain core management and technical competency but rely on associates and specialists for extra help and special expertise during peak times.

Contracts are becoming the hiring norm

When a project is finished, overhead is minimized by maintaining skeleton staffs with minimal office space. In some provinces during the early 1990s, many sole proprietors benefited from this practice.

Increasingly, unless they are principals of their own firms, consulting engineers work on a project-by-project basis, and are paid on a contract basis. The short-term, project-by-project job structure requires continual self-marketing and a broad set of entrepreneurial skills to win contracts. The benefit is that, with good time management and the use of flexible working hours, both management and contract engineers can enhance their personal freedom and choice. For organizations without a continuous stream of similar project work, contracting decreases the need for in-house staff and generally improves access to required skills and experience on a temporary basis. Contracting out can also contribute to independent firm growth through export market development.

This trend poses challenges to consulting engineering firms in terms of achieving an appropriate balance between core and contract staff and in providing staff with the skills they need through training and life-long learning initiatives. Professionals skilled in computer-aided design and drafting (CADD) and computer-assisted engineering design (CAED) programs and innovative industry techniques are more likely to obtain continuing employment than those who are not. However, leading-edge computer technology is continually evolving, and user skills in a particular program are short-lived. Thus, the emergence of the "knowledge economy" has contributed to increased short-term employment in this industry.

"... now you need an engineer to handle not only the machinery but also the people."
— Peter Jansen, President and CEO, Asea Brown Boveri

Skill requirements include advanced technical and computer, marketing and self-promotion, and entrepreneurial skills

Throughout the industry, attitudes are changing toward a philosophy of life-long learning, because independent consulting engineering entrepreneurs are marketable only so long as they grow and enhance their expertise. The rapid evolution of a technology is affecting the type of training required both in universities and on the job. In addition to advanced technical and computer skills, young graduates need more sophisticated training in project planning, financing and operating as well as marketing and self-promotion. To succeed, they must continue to demonstrate their competitive advantage in domestic and international markets.

Skills and technology must match client needs

Consulting engineers also need to match computer skills and software with client systems. Consulting engineers must be able to work with client software, or at least transfer work to software that will perform similar functions. Clients demand the use of up-to-date software, not only to enhance engineering productivity but also to interface with their own technologies.

Emerging fields demand new skills

New and emerging areas in consulting engineering such as environmental services, integration of manufacturing processes, health, geographical information systems and software development must also be matched with the appropriate human resources skills. New university graduates are increasingly being recognized as possessing very relevant basic skills in new information technologies that are not readily available elsewhere. Increasing numbers of women students are enrolled in engineering curricula, but the number of women employed in the industry remains low.

Through programs such as Industry Canada's Youth Internship Program, which began in December 1994, the government will provide consulting engineering firms access to young people with skills relevant to the needs of their industry. As well, Industry Canada's Student Connections Program, launched in March 1996, will assist firms nation-wide in taking advantage of the information potential of the Internet. This program will further the government's priorities of youth, technology and trade in support of jobs and growth.

3.4 Technological Change

Information technologies are defined in a recent report undertaken for the Consulting Engineers of Ontario as all technologies used to process, store and transmit data. The report predicts they will become a pillar on which the professional consulting engineer builds his or her specific expertise, tools and competitive practice for the future.

The report recommends sector-specific strategies focussing on information technology to enable strategic alliances, global competitiveness and the extension of skills into new business areas. For example, information technologies are fundamental tools for firms diversifying into areas such as geomatics. The report also indicates a need for stronger links between the industry and centres of excellence.

Information technology will create alliances, global competitiveness and the extension of skills in new business areas

Consulting engineering firms are critically important agents in the technology diffusion process in Canada. They apply advanced technologies in their project design and development work. They import technology developed in projects abroad and diffuse them by undertaking similar projects in Canada, and vice versa. And they are leading-edge technology users,

particularly information technologies. Part of the *Framework for Action* for this industry will look at ways to strengthen the capabilities of consulting engineering firms in areas such as advanced manufacturing technologies, geomatics, systems integration, environmental technologies, etc. By so doing, the industry will strengthen its role in promoting technology diffusion in Canada throughout the numerous industries that employ consulting engineering services.

3.5 Sustainable Development

Canada has global expertise in sustainable development

Cleaning up the world environment and introducing cleaner technologies is emerging as one of the most pressing issues in this and the next century. While less organizationally integrated than its competitors, the Canadian consulting engineering industry is amassing considerable technical expertise in environmental services in areas such as hazardous waste, solid waste, water and waste water, air pollution, recovery and recycling.

Reducing environmental stress will require strategic alliances between firms in developed and developing countries as well as between companies with the expertise and engineering capability to participate successfully in the transformation of industrial processes.

Tremendous new opportunity exists to design and build environmentally sound infrastructure and other projects from the ground up. Newly wealthy and developing countries are facing a substantial pollution load due to a combination of old, polluting industries and inadequate infrastructure.

Consulting engineering firms will benefit from the federal government's Environmental Industry Strategy, whose three main objectives are to improve the environmental industry's access to government programs and services, support technology development and commercialization, and increase the role of Canadian firms in both the domestic and international environmental markets.

The environmental sector will offer outstanding market prospects for consulting engineers — $8 billion annually in Canada alone

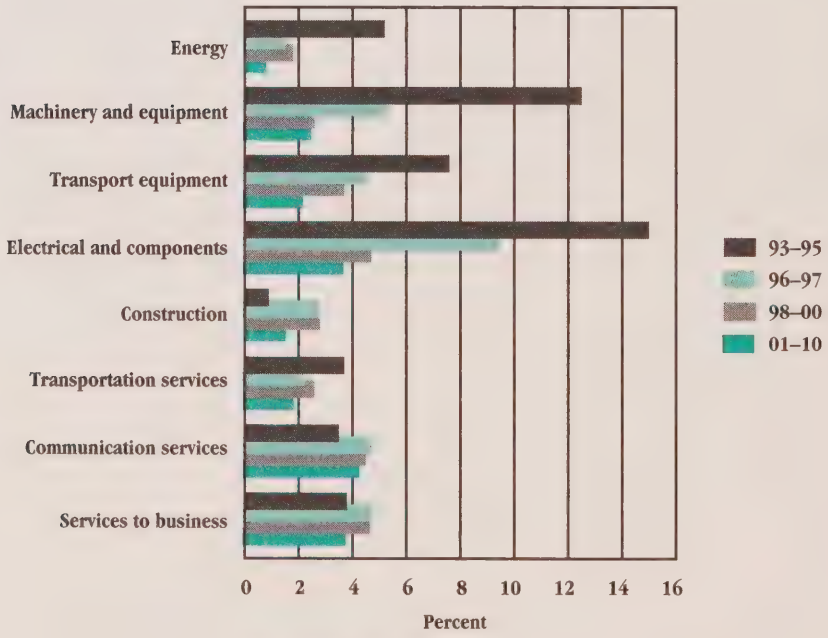
4 GROWTH PROSPECTS

4.1 Demand Outlook

Short-term domestic demand: strong in electrical, machinery and equipment, transport, business services

In Canada, increased net exports of both goods and services, and strong investment in machinery and equipment, led the 1992–95 recovery in business activity (Figure 15). The Canadian economy has been helped considerably by a strong U.S. recovery, a low exchange rate for the Canadian dollar and falling unit production costs relative to those of foreign competitors. Informetrica, a leading Canadian forecasting firm, predicts that the Canadian economy will continue to benefit from strong growth in North American durable consumer goods and investment-sensitive industries. Informetrica anticipates strong growth in the short term from electrical and components industries, machinery and equipment, transportation equipment, and services to business including software providers and other Information Highway suppliers. This in turn should benefit consulting engineering firms in these fields, especially communications and micro-electronics consulting engineers.

Figure 15. Rates of Growth Predicted in Industries Impacting on Consulting Engineering



Source: Informetrica, 1995.

Long-term overall domestic demand slowing

Informetrica predicts that domestic growth in real capital formation over the short term will stay in the 3 percent range. This is below the annual pre-recession average of 3.6 percent between 1983 and 1989. Although investment is expected to pick up in the second half of the 1990s, it will be rising from a weak base. Many of Informetrica's domestic industry forecasts for the long-term outlook show reduced average annual growth during the 2001–10 period compared with performance in 1996–97 and 1998–2000. Informetrica does not expect investment as a proportion of gross domestic product to reach the pre-recession level of 20.9 percent until 2001–10. This prediction implies weak overall domestic demand for consulting engineers. Areas such as electrical and electrical components, communication services and services to business, however, are expected to show relatively strong growth in the long term.

Significant global potential

In global markets over the short term, significant opportunities for consulting engineers are emerging as a result of NAFTA; political changes, especially in eastern Europe; the privatization trend, particularly in less developed countries; and continuing strong growth in Latin America and the Pacific Rim.

Asia now top market

Asia including China, Indonesia, Malaysia, Singapore, Taiwan, Thailand, Hong Kong and the Republic of Korea is the top regional engineering design market. This region has surpassed Europe, where economic slowdown has led to declining infrastructure investment. India is fast becoming a magnet for design firms.

Both Asia and the Middle East have rapid economic growth, relatively stable governments, high foreign exchange reserves and low foreign debt. They also have extensive needs for infrastructure and engineering services. However, Japan's construction engineering market, although large, remains virtually inaccessible to foreign companies.

Eastern Europe and the former Soviet Union strong, with obstacles

While demand for engineering services is strong in eastern Europe and the former Soviet Union, currency constraints and structural barriers have curtailed substantial economic growth. Other problems in this part of the world include unresolved land ownership issues, lack of project development capabilities and obsolete engineering techniques and technology. The most serious short-term constraint is the lack of investment capital, although IFIs such as the World Bank are becoming more active there. Canadian engineering companies seeking contracts in this part of the world will be required to structure and work with creative financing packages, and to make connections with resource processors who generate hard currency.

Latin America strong , with high external debt

While Latin American markets offer strong engineering and related opportunities, high external debt, and a possible recurrence of currency fluctuations and inflation in these countries continue to pose some risks for potential players in large projects. Nevertheless, increasing political stability and growing privatization are providing exceptional opportunities for Canadian players willing to face the risks in target countries.

Major infrastructure development in Mexico

Mexico has accelerated its infrastructure development program and has initiated a myriad of large projects in environmental control, water purification and distribution, hydro-electric power and energy distribution.

"Partnerships are the only way for Canadian companies to gain the critical mass to move into foreign markets."
— Tony Burges, Director, ACEC

Canadian companies are carefully reassessing their marketing strategies to cope adequately with intensified global competition. One likely impact of the sluggishness of the European and U.S. economies is the keener competition that firms in these countries are mounting toward Canadian counterparts in newly developed and developing markets. Canadian firms that can form partnerships and strategic alliances with local firms will find enhanced opportunities. Co-venture projects give all participants powerful incentives to minimize costs, including interest, during construction.

Global population growth over the longer term will create substantial demand for infrastructure and engineering services, primarily in newly developing economies. In these countries, rapid migration to large urban centres will create enormous pressure for new investment in transportation, communications, water and sewage systems, housing, roads, hospitals and schools. These countries will also require large capital investments in power plants, telecommunications systems, ports, railways, roads, bridges, and energy distribution systems, particularly for distributing gas.

Global demand huge in developing economies as populations urbanize

While meeting these demands, the global necessity to focus on sustainable development, and thereby reduce environmental stress, will require more highly engineered projects and different mixes of machinery and equipment than are currently available.

Sustainable development will require highly engineered projects

4.2 Key Industry Strengths

As a whole, the Canadian consulting engineering industry is an effective global player in innovation, technology diffusion, skills development and knowledge transfer. Canadian engineering companies are most successful at the design phase. They are important agents for change and technology diffusion throughout Canadian industry.

Canada's strengths include technology development and transfer . . .

Typical of the business services industries and in contrast to goods producers, the industry maintains a strong focus on human capital. Firms demonstrate a multidisciplinary and multilingual wealth of talent. Canadian firms have a competitive advantage in resource extraction, energy production and infrastructure engineering.

resource extraction, energy production and infrastructure engineering . . .

a reputation for integrity

Other strengths include integrity and a reputation for quality engineering services, international success through participation in large projects, and an ability to adapt to unfamiliar cultures and constraints as well as to adapt to changing market conditions and new technology.

4.3 Current and Anticipated Challenges

Challenges facing Canada include more BOOT and build-own-transfer capacity, better links with manufacturing and banking sectors . . .

Canadian performance abroad is being hindered by the following factors:

- too few firms with design-build, turnkey and BOOT capabilities
- inadequately developed relationships with the manufacturing, banking and financing sectors
- the lack of coordination among government departments and agencies.

Specifically, firms need to expand their capacity to engage in all project phases, including operations and downstream business, and particularly Canadian participation in construction and supplier contracts for equipment and machinery. Canadian consulting engineering firms may be "export ready," but many have not yet taken the leap. Project financing and risk management will continue to be basic constraints for such firms.

better international financing, adapting to weak domestic demand, meeting interindustry competition and facing fee competition

Other challenges evident among many Canadian consulting engineering firms are:

- the difficulty in capturing procurement contracts involving IFI financing, other than at the design phase
- slowness in moving toward a European model of organizational structure that incorporates horizontal and vertical integration
- a need for a more global orientation

- restrictions on human resources development stemming from the growing project-by-project orientation, which may hinder the sustained professional training vital to long-term success
- the reluctance of firms to change their organization style and business culture amid weak domestic demand, especially for infrastructure engineering
- interindustry competition from systems integrators and management consultants for the same market segments on the domestic front and in new emerging countries on the international front
- intense fee competition among bidders.

The following obstacles hinder both domestic and foreign private financing of BOOT-type or integrated projects:

- the lack of unencumbered financial leverage or "free" tangible assets
- weak profitability
- the lack of in-house multidisciplinary skills.

As well, Canadian banks are not as active as those in competitor nations in international project financing. Therefore, many Canadian firms find it difficult to survive the setbacks inherent in international project cycles or to expand when opportunities arise.

4.4 Future Opportunities

Future domestic opportunities lie in the knowledge-based service components of consulting engineering. Promising areas are geographic information systems, software development and applications, engineering services to telecommunications and other high-end machinery and equipment industries, as well as environmental services and manufacturing processes.

Canada's domestic opportunities lie in knowledge-based components of consulting engineering and information industries

Canada's opportunities abroad lie in integrated projects

Canadian companies will be challenged to find new ways to increase Canadian design-build, turnkey and BOOT or BOT (build-own-transfer) capacity to provide a full range of engineering services to developing economies. Successful firms, however, will find increased opportunities. While infrastructure, energy production and resource-based engineering may decline in this country, Canadian expertise will be applicable in major overseas projects arising in the foreseeable future.

Canada's current goal is to increase procurement of Canadian goods and services by IFIs

The federal government in April 1994 set up an Interdepartmental Task Force on IFI Procurement, which made its final report in June 1995. Acting on its recommendations, the federal government then created a Capital Projects Action Team comprising the Department of Foreign Affairs and International Trade (DFAIT), the Export Development Corporation (EDC), the Canadian International Development Agency (CIDA), the Canadian Commercial Corporation (CCC), the Department of Finance and Industry Canada. Its mandate is to oversee a three-year action plan to increase procurement of Canadian goods and services by IFIs, thereby improving Canadian access to IFI financing, matching funding and privately financed projects.

In sum, Canadian firms can increase their international participation by building on their niche markets and specializations, and by addressing the evident challenges.

4.5 The Bottom Line

Global opportunities for consulting engineering are large. Canadian firms have a competitive advantage in resource-based, energy-related and infrastructure projects. Many are moving to develop new specializations in fields where new market opportunities have arisen. However, they must overcome significant challenges if they are to benefit from the global opportunities.

The following issues must be addressed by government and industry.

Canada must address trade issues . . .

In trade, Canadian firms must become increasingly involved in providing the full range of services associated with design-build, turnkey and BOOT-type projects, engaging in all implementation phases and capturing the benefits of downstream business. Their success in the future will depend on more effective consortia building based on stronger linkages with a number of key sectors, including the financial sector. Success must be achieved in overseas markets, particularly in Asia and Latin America, for both IFI and privately funded projects, including projects resulting from privatization. Canadian firms need to pursue proactively such linkages to win contracts against larger U.S. and European firms and benefit from all project stages.

A greater number of firms in the industry need to become export-oriented in order to take advantage of growing international opportunities. Canadian financial institutions must be encouraged to play a stronger role in international project financing. The government must achieve a more strategic coordination of its programs and services in support of the international business development interests of the industry. The degree of impact of each of the non-tariff barriers to the U.S. market needs to be re-examined in the light of NAFTA provisions, to determine appropriate recommendations for action.

human resources issues . . .

In human resources development, firms need to concentrate on an array of skills in support of developing strong expertise in new areas of specialization. Firms and professionals must place continuing emphasis on life-long learning to retain competitive skills advantages in domestic and international markets. Especially important are technical skills, project management,

marketing, business and financial management skills and entrepreneurship. Another area that should be addressed is the need to link industry compensation and reward systems to performance and achievement of goals.

environmental issues . . .

The growing global concern for environmental quality requires consulting engineers to make sustainable development an integrated component of the engineering services they offer. The federal government's Environmental Industry Strategy is one avenue through which firms can augment their capabilities in sustainable development and increase their opportunities abroad.

and technological issues

Government and private initiatives are required to strengthen the capabilities of consulting engineering firms in such areas as advanced manufacturing technologies, geomatics, systems integration and environmental technologies in order to offer new consulting services in growth markets. Information technologies are needed by consulting engineers to optimize processes, preserve the knowledge of an aging work force through such methods as expert systems, and promote synergy as a means of packaging services. Success in these areas will contribute to the objective of encouraging the diffusion of best practices and leading-edge technologies among the Canadian industries that procure consulting engineering services. Stronger links are required between industry and centres of excellence to ensure more effective technology transfers to Canadian industry.

Organizational innovation needs to be synchronized with technological innovation. The innovation process is itself not well understood and needs to be properly defined. Understanding the innovation process better could reduce the time required to find solutions. Further training is basic to optimal diffusion of advanced technologies within the profession. Technology adoption costs are a necessary business expense and may be shared by pooling financing and operations among small firms.

By meeting these challenges, the Canadian consulting engineering industry can maintain its importance in the domestic economy and improve its performance in rapidly growing international markets for capital projects.

This *Overview and Prospects* will be followed by a second document, the *Framework for Action*. Based on consultations with key stakeholders, the *Framework for Action* will examine key issues in further detail and lay out joint actions.

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Annex A
ENGINEERING SERVICES AND INDUSTRY MODELS

The main services provided by consulting engineers in 1992, in order of volume, were: design services 41 percent, advisory services 13 percent, turnkey projects 7 percent, project management 10 percent, design services/environmental 7 percent and construction management 7 percent.

Consulting engineering services tend to fall within three categories:

- general services — feasibility studies, preparation of detailed drawings, specifications and contract documents, and supervision of construction
- specialized services — design and development of process equipment, environmental advisory and design services, materials testing services, software or custom systems development and project management
- comprehensive or turnkey services — manage-engineer-procure-construct (MEPC) and build-own-operate-transfer (BOOT) contracts, which often involve the provision of financing, real estate, equipment procurement, construction, facility management and training programs.

Consulting engineering firms are organized according to either the "Anglo Saxon" model or variations of the "European" model. Firms of the first type are relatively independent; that is, they are not controlled by an industrial group. They perform pure engineering functions and are remunerated on a cost-plus-fee basis. The "build" portion then becomes the responsibility of the contractor or equipment supplier, according to the engineering designs.

In contrast, firms organized according to the European model are equipped to design-build, or to carry out turnkey (design, build, procure equipment and commission projects), or to build, own, operate and transfer projects. While some of these firms retain their independence, others display a wide range of business structures and relationships, often linked to industrial groups, government entities, public utilities and equipment manufacturers. While some provide a full range of engineering design and construction services under one roof, others will put together the requisite project team.

While BOOT-type firms are still less prevalent in Canada than in Europe and the U.S., increasing emphasis on offshore markets and project financial participation presents considerable opportunities for Canadian firms willing and able to develop BOOT capability. Many Canadian firms are rising to the challenge, especially in the environmental services and manufacturing field. They are designing refuse systems, machinery and equipment, and software development in addition to direct engineering services. Some Canadian consulting engineering firms are substantially involved in physical and biological research with linkages to the engineering discipline.

SNC Lavalin, organized on the European model, is a major holding company involved in heavy construction, general construction, and ammunition and communications equipment manufacturing, as well as direct engineering services. Another example is AGRA Industries, which finances and builds toll highways, including the Metro Toronto Highway 407 project.

Annex B
FOREIGN COMPETITORS

In the United States, most large firms involved in consulting engineering in the international market have been active globally for a decade or longer. American firms have increased their expertise in offering "one-stop shopping." The role of construction firms has become more important, and U.S. construction firms are world leaders particularly in terms of technology and project management expertise.

The line delineating construction firms from consulting engineering firms has become quite blurred in recent years for the successful international U.S. companies. As well, American firms have done well in Europe (and more recently in eastern Europe) in serving the large U.S. multinationals operating in these regions. The multinational firms tend to hire consulting engineers with whom they have worked previously and, in effect, "pull" American engineering firms around the world.

In the United Kingdom, independent consulting engineering firms predominate. Many British consulting engineering firms are large, with more than 1000 employees. In addition to private firms, there are public sector subsidiaries comparable with the "SOFRE" (Sociétés Françaises pour l'exportation) in France. These are in the nuclear, electrical, water, coal and railway sectors. However, privatization of some of these organizations is taking place, thereby increasing export potential.

In France, the consulting engineering sector is characterized by relatively small firms with highly visible involvement of parastatal agencies. This is exemplified by the SOFRE, which are state-controlled, such as SOFREGAZ, SOFRETEV, SOFRECOM, SOFRERAIL and SOFRETU. As well, numerous financial institutions such as la Banque Paribas and le Credit Lyonnais are present in the consulting engineering industry through minority ownership. There is also a considerable degree of integration between consulting engineering firms and industrial conglomerates such as Bouygues.

Engineering within government departments in Germany is characterized by capabilities within federal and lander (state) administrations, as well as within municipalities and national enterprises such as Deutsche Eisenbahn Consulting, DETECON, Deutsche Telepost Consulting or Lufthansa Consulting. The consulting engineering sector in Germany differs significantly from the Anglo Saxon model, which is the industry norm in the United States, the United Kingdom and Canada. The German industry is characterized by powerful engineering services linked to industrial equipment manufacturing. These firms have developed an engineering capability to complement their services, often through the acquisition of independent engineering firms.

The Netherlands industry is characterized by independent consulting engineering firms, flexible consortia and research institutes. Engineering services provided by government entities are also prevalent, but only in certain sectors such as water and electricity. The Netherlands consulting engineering industry exhibits great coordination capabilities between firms, as exemplified by groupings of independent firms under the names NEDECO and NETHCONSULT, primarily for export purposes.

While excellent at the design phase, Canadian firms are less successful at turnkey or BOT (build-own-transfer) projects. By contrast, U.S. firms offering major construction and project management services are often very successful, especially in chemicals, petrochemicals, refining and power. The European and the Japanese counterparts often succeed in bidding on international projects where all the individual components are integrated on a price-competitive basis.

Annex C
FORMS OF INNOVATION

Engineers have automated their own operations through a variety of ways:

- proprietary computer-aided design and drafting (CADD) software systems capable of tripling productivity
- interactive CADD systems with on-line databases that automatically issue change notices, revised drawings and updated material bills
- computer-assisted engineering design (CAED) systems, which calculate elements such as structural analysis, foundation design, slope stability and earthquake resistance
- systems that tie CADD systems directly into construction software for estimating, project scheduling, cost control and materials tracking.

Project management innovations and proprietary construction techniques can reduce construction costs. Currently, most companies work with several independent databases, moving control from one to the other during successive stages in design and fabrication. Emerging computer-based construction management systems integrate these databases with procurement decisions. They smooth the flow of work, reduce inventories during construction, improve productivity and cut costs.

Superior technological expertise can save on operating costs. Most successful design firms have the expertise not only to design more efficient plants, but also to make incremental improvements over previous designs. This expertise, and associated hardware and software, are also assisting firms to diversify into areas such as geomatics and environmental waste handling systems, including robotics and remote control mechanisms for handling dangerous materials.

Proprietary processes open doors to emerging or established markets. "Improved processes" lower design, construction or operating costs, and "new processes" make the process cost-effective the first time, thereby opening up new markets. By developing proprietary process technology, firms may be able to insist on handling contracts on a turnkey basis, thereby avoiding the need for separate design and construction bids. Such turnkey contracts allow consulting engineering firms to minimize project life-cycle costs, rather than just design costs.